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DISTRIBUTION, DENSITY, AND PRODUCTIVITY OF ACCIPITER HAWKS BREEDING IN OREGON

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Density of nests and productivity of Sharp-shinned Hawks (*Accipiter striatus*), Cooper's Hawks (*A. cooperii*), and Goshawks (*A. gentilis*) within Oregon are of interest because of recent declines of accipiter hawks in the eastern United States (Schriver 1969, Hackman and Henny 1971, Henny and Wight 1972). One factor implicated in this decline was contamination with chlorinated hydrocarbons (Ratcliffe 1970, Cade et al. 1971, Anderson and Hickey 1972, Wiemeyer and Porter 1970). Snyder et al. (1973) presented data on levels of DDE in eggs of accipiter hawks from various regions in North America, including Oregon. Their data indicated that eggs of each species are contaminated, but they were unable to evaluate the effects of contamination on populations in Oregon as historical data on the abundance of breeding accipiters did not exist.

This paper presents information on the distribution of nests, nesting density, and nesting success of Sharp-shinned Hawks, Cooper's Hawks, and Goshawks in Oregon. In an attempt to assess current production trends, nesting densities and productivities of Oregon accipiters are compared to densities and productivities of accipiters elsewhere in North America and, where appropriate, in Europe.

METHODS

This study included a survey for accipiter nests in all major forest types in Oregon except the western juniper (*Juniperus occidentalis*) forests in central Oregon and the Sitka spruce (*Picea sitchensis*) forests along the northwest coast. Forests included in this survey contain a wide variety of tree species, though with few exceptions, conifers are dominant. These forests are primarily restricted to montane areas and vary from the extensive and continuous forests of the Coast and Cascade ranges to the disjunct forests of smaller mountain ranges east of the Cascades.

We divided Oregon into 3 subregions: (1) the Coast Range and the west slope of the Cascade Range, a moist, densely forested region with a mild maritime climate, referred to as western Oregon; (2) southwestern Oregon, which includes the Siskiyou Mountains, characterized by relatively warm, wet winters and hot, dry summers; and (3) eastern Oregon (including the east slope of the Cascade Range), a high elevation and more dry region with affinities to the Rocky Mountain forests. Franklin and Dyrness (1973) presented a list of the vegetational zones and associated tree species plus the edaphic and climatic characteristics of these sub-regions. Nesting success and distribution of nesting pairs of accipiters were determined during the breeding seasons of 1969 through 1974. During 1969 and 1970, all forest stands were searched for nests. However, after

[1] Deceased.

learning to recognize the structural characteristics of forest stands selected by each species for nesting, the amount of forest intensively searched was reduced. Searching only stands considered potential nest sites proved suitable for surveying large areas, but undoubtedly caused us to overlook some nests. Searches conducted during the 6 breeding seasons disclosed 117 nest sites and 139 attempts at nesting.

Nest density for each species was determined by intensively searching the Corvallis and Bly study areas. The Corvallis study area, 9284 ha. was located on the east slope of the Coast Range approximately 8 km northwest of Corvallis, Benton Co. (T. 10S and 11S; R. 5W and 6W) (Fig. 1). Elevation of this area ranged from 80 to 500 m and was of moderate relief. Except for some narrow valley bottoms (fenced pastures) and one burn in various stages of regeneration, the forests of this study area were continuous. Douglas-fir (*Pseudotsuga menziesii*) was the dominant tree species and it existed in pure stands or mixed with western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), or bigleaf maple (*Acer macrophyllum*). On some dry, south-facing slopes, small stands of Oregon white oak (*Quercus garryana*) persisted. A major portion of the Corvallis study area was composed of young (<100 years) stands of Douglas-fir, though stands of all age classes were represented. This area was searched during the nesting seasons of 1970 and 1971.

The Bly study area, 11,741 ha. was in the Gearhart Mountains approximately 24 km northeast of Bly, Lake Co. (T. 15E and 16E; R. 36S) (Fig. 2). Elevation of this area ranged from 1430 m to 2130 m and was also of moderate relief. Except for 2 burns which were in young regenerative stages and small natural openings, forests of this area were continuous. Tree species composition varied from pure stands of ponderosa pine (*Pinus ponderosa*) at lower elevations (southwest portion), through mixed stands of ponderosa pine and white fir (*Abies concolor*) at mid-elevations, to mixed and pure stands of white fir and lodgepole pine (*Pinus contorta*) at high elevations (north and east portions). Stands of all age classes in each timber type were represented; however, the most common type was mature ponderosa pine overstory with mixed understory of ponderosa pine and white fir. The Bly area was searched during the nesting season of 1974.

Data from these 2 areas also provided mean distances between nests of conspecifics. Since several researchers (e.g., Hoglund 1964) reported only distances between nests, we include a mean distance to make the dispersion of nests in our study areas comparable. We determined this by locating nests on maps and measuring the distance between each active nest and its nearest neighbor, using the distance between any 2 nests only once. Since some pairs used different nest sites from year to year, distances between nests were calculated on a yearly basis, using each nest as a single observation. Nest sites were visited up to 2 months after fledging to determine the length of time young remained in the nest area under care of the adults.

RESULTS AND DISCUSSION

Distribution of nesting pairs.—Of the 139 nesting attempts, 16 were Sharp-shinned Hawk, 42 were Cooper's Hawk, and 81 were Goshawk.

All 3 species were found nesting in eastern, western, and southwestern Oregon. Sharp-shinned Hawks nested in the Coast and Cascade ranges, the Siskiyou, Gearhart, and the Steens mountains at elevations ranging from 120 m in the Coast Range to 2010 m in the Gearhart Mountains. Cooper's Hawks nested in the Coast and Cascade ranges, the Siskiyou, Wallowa, and Gear-

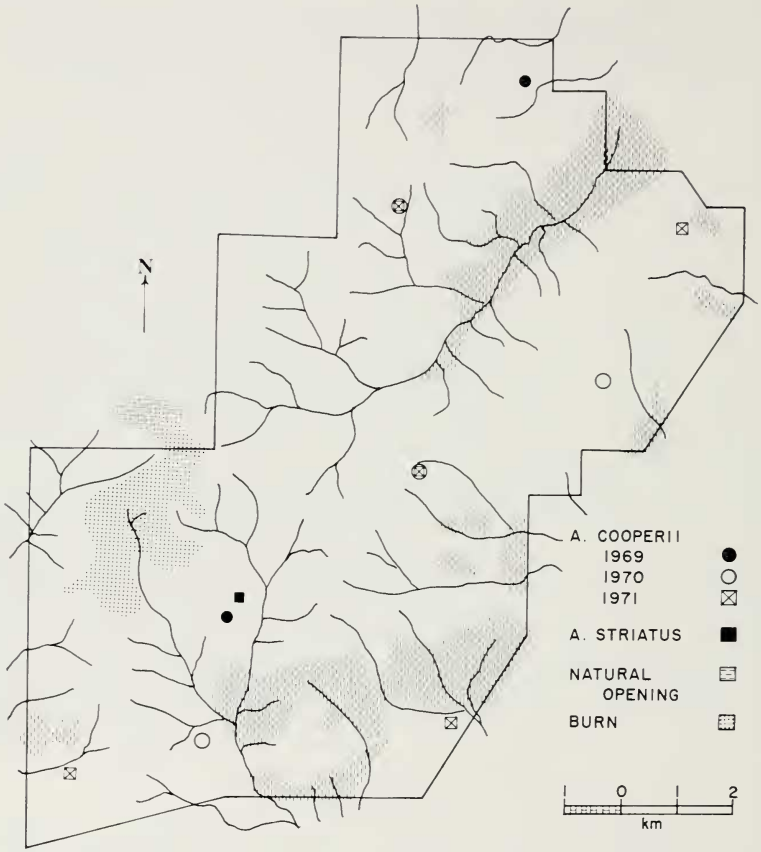

FIG. 1. Corvallis study area. Illustrating main drainages and accipiter nest locations in 1969, 1970, and 1971.

hart mountains. This species also nested in the floor of the Willamette Valley (western Oregon) in isolated, but extensive stands of Douglas-fir. Elevations of Cooper's Hawk nests ranged from 15 m in the Willamette Valley to 1760 m in the Gearhart Mountains. Goshawks nested on both east and west slopes of the Cascade Range, the Siskiyou Mountains, and in all mountain ranges in eastern Oregon. Elevation of Goshawk nests ranged from 580 m on the west slope of the Cascades to 1860 m in the Gearhart Mountains. Nests of Goshawks were not found in the Coast Range.

The relative abundances of nests of each accipiter species in our statewide sample possibly reflected the relative difficulty of locating nests rather than their actual abundances. Goshawks, because of their large size, are the

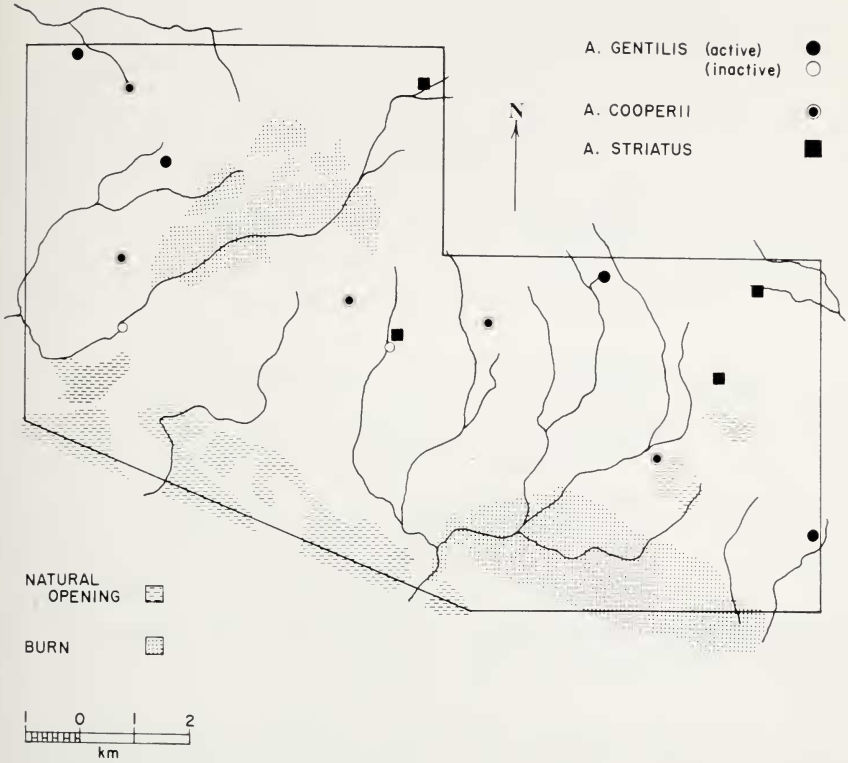

FIG. 2. Bly study area. Illustrating main drainages and accipiter nest locations in 1974.

easiest to locate; whereas Sharp-shinned Hawks, the smallest accipiter in Oregon, are the most difficult. This bias in our sample makes it appear that Sharp-shinned Hawks are the least abundant of the Oregon accipiters, while the opposite may be true (see below). We feel that, with the possible exception of Sharp-shinned Hawks in Western Oregon, the relative density of each species in the Corvallis and Bly areas approximates the actual densities of nesting accipiters in each region.

Nest densities and spacing.—Portions of the Corvallis study area received a cursory nest search in 1969; 2 Cooper's and 1 Sharp-shinned hawk nests were located. Four Cooper's Hawk nests were located in 1970 and 5 in 1971 (Fig. 1), resulting in 1 nest per 2321 ha in 1970 and 1 nest per 1857 ha in 1971. Mean distance between nests was 5.0 km in 1970 (range = 3.7–6.3 km, SD = 1.29 km) and 5.5 km in 1971 (range = 4.8–6.9 km, SD = .97 km). No nests of Sharp-shinned Hawks were located in this study area in 1970 or 1971.

Table 1
Nest Site Tenacity of Accipiter Hawks in Oregon, 1969–1974

		Number of Years of Occupancy							Reoccupancy Rate
		1	2	3	4	5	6	R/R[b]	
	Number of nest sites revisited		5	3	3	0	0		
Sharp-shinned Hawk	Number of nest sites reoccupied	3[a]	2	0	0	–	–	2/11	.18
	% reoccupancy		40	0	0	–	–		
	Number of nest sites revisited		22	9	3	0	0		
Cooper's Hawk	Number of nest sites reoccupied	16[a]	6	1	0	–	–	7/34	.21
	% reoccupancy		27	11	0	–	–		
	Number of nest sites revisited		35	17	7	4	0		
Goshawk	Number of nest sites reoccupied	20[a]	15	7	2	1	–	25/63	.40
	% reoccupancy		43	41	29	25	–		

[a] Number of sites occupied for 1 year only.
[b] Number of sites reoccupied/number of sites revisited.

In 1974, 4 Sharp-shinned Hawk nests, 5 Cooper's Hawk nests, and 4 Goshawk nests were located in the Bly study area resulting in an overall density of 1 nest per 903 ha or 1 Sharp-shinned Hawk nest per 2750 ha, 1 Cooper's Hawk nest per 2200 ha, and 1 Goshawk nest per 2750 ha (Fig. 2). Mean distances between nests of conspecifics were: Sharp-shinned Hawks, 4.1 km (range = 1.8–6.0 km, SD = 2.12 km); Cooper's Hawks, 3.5 km (range = 2.6–4.4 km, SD = .79 km); and Goshawks 5.6 km (range = 2.4–8.4 km, SD = 3.00 km) (Table 1).

Two Sharp-shinned Hawk nests were approximately 300 m from active Cooper's Hawk nests, and 1 Sharp-shinned Hawk nest was approximately 450 m from an active Goshawk nest. Five Cooper's Hawk nests were between 300 to 450 m from active Goshawk nests. In 2 of the latter cases, both species used the same nest sites for 2 consecutive years. In all the above situations, only 1 nest, a Sharp-shinned Hawk adjacent to a Cooper's Hawk, failed to fledge young.

Mean distance between nesting pairs of Cooper's Hawks in the Bly and Corvallis areas was considerably greater than the approximate 1.6 km between nests found in Arizona (N. Snyder pers. comm.) and in California (Fitch et al. 1946). Meng (1951) did not determine a mean distance between

30 nests of Cooper's Hawks in New York, but reported that the 2 closest nests, on opposite edges of 2 extensive woods separated by a large field, were 2.4 km apart.

Mean distance between adjacent pairs of Goshawks in the Bly area was essentially the same as reported for European Goshawks (*A. g. gentilis*) in Sweden (5.5 km, range = 3.9–8.0 km) (Hoglund 1964). While McGowan (1975) did not report a mean distance between any of 9 active nests in Alaska, he found a density of 1 pair per 4869 ha in 1971 and 4142 ha in 1972, only half the density of Goshawks in Oregon. In Finland, a density greater than that in Oregon has been reported—1629 ha per pair (9 pairs) (Hakila 1968).

Nest site tenacity.—Nest sites of accipiters were defined as the portion of a forest stand containing the nest and the requisite structural features of the vegetation (density, height, canopy closure) and physiographic conditions (slope, aspect, surface water) used by a nesting pair during the breeding season. In Oregon, the area within a nest site increased with increasing accipiter size, ranging from approximately 4 ha for Sharp-shinned Hawks, 6 ha for Cooper's Hawks and 8–10 ha for Goshawks.

Many established nest sites of each accipiter contained more than 1 nest. We did not observe Sharp-shinned or Cooper's hawks reoccupying an old nest. If a pair of either species returned to a previously used site, a new nest, usually within 100 m of the old, was constructed. In contrast, many pairs of Goshawks used the same nest for 2 or more years or alternated between 2 or more nests within an established site. Alternate nests within an established Goshawk site varied from 15 to 150 m apart, though most were 60–90 m apart. In addition, several pairs of Goshawks had alternate nest sites, usually within 0.4 km, between which they shifted on a 1–3 year basis. In general, nest site tenacity increased with increasing accipiter size. The maximum number of years a nest site was occupied was 2 years for Sharp-shinned Hawks, 3 years for Cooper's Hawks, and 5 years for Goshawks (Table 1).

For one reason or another an established pair of Goshawks may desert one nest site for another up to 3.5 km away. For example, in 1974 one pair of Goshawks on the Bly study area, which used one site for several years, moved 3.2 km north to a site which was approximately 2.4 km south of another active Goshawk nest. Since these hawks were not marked, we were not certain that both nest sites had been occupied by the same pair. However, frequent sightings of the male foraging within areas used in previous years and carrying prey from these areas toward the new site suggested that the same pair was involved. Nest site shifts of this type occasionally placed conspecific pairs in close proximity (less than 3.5 km apart), though none of these situations was found to persist for more than one breeding season.

Three shifts of nest sites, averaging 3.1 km (range = 2.6–3.2 km) were also noted for Cooper's Hawks in the Corvallis study area. Although not certain the same pairs were involved, we observed both single and pairs of hawks flying between old and new nest sites on several occasions before egg laying.

In 2 instances, nest sites of 1 species were occupied during subsequent breeding seasons by other species. The first of these involved a site used for 2 seasons by Sharp-shinned Hawks prior to its being used in the third year by Cooper's Hawks. Another involved a site used by Goshawks for 2 years prior to its being occupied by Cooper's Hawks. No interactions between pairs involved were noted.

Initiation of breeding and egg laying.—One pair of Goshawks was first noted in its nest site on 23 March, and most pairs were found in their sites by early April. In Oregon, the date of clutch completion and initiation of incubation by Goshawks was highly variable. The earliest clutch was completed about 10 April, and the latest, 2 June (Fig. 3). However, most clutches were completed and incubation began within the last week of April and the first 2 weeks of May, approximately the same period reported by McGowan (1975) for Goshawks in interior Alaska.

Regression analysis suggested little association between the date of initiation of incubation and the elevation of 30 Goshawk nests in Oregon, for all years combined as well as in any single year.

One pair of Cooper's Hawks was first noted in its nest site on 28 March (western Oregon), while most pairs throughout Oregon were observed in or about the nest sites by mid-April. In western Oregon, clutches were completed and incubation began during the last week of April through the third week of May, while those in eastern Oregon were completed during the third through the last week of May (Fig. 3). The earliest completed clutch for Cooper's Hawks was 1 May (western Oregon), and the latest, 30 May (eastern Oregon).

One pair of Sharp-shinned Hawks was first noted in its nest site on 9 May, 6 days before the first egg was laid. On this date the nest was complete, indicating that the hawks had probably been at the site for at least a week prior to 9 May. Clutches of Sharp-shinned Hawks were completed and incubation began sometime in May, although some may not be completed until mid-June (Fig. 3). The earliest completed clutch was 14 May and the latest 19 June.

Due to the narrow range of elevation over which we found nests within each subregion and because our sample of Cooper's and Sharp-shinned hawk nests is not continuous over the entire range of elevation from western to eastern Oregon (highest in western Oregon, 600 m; lowest in eastern Oregon, 1400 m), it was difficult to determine whether or not there was an association between elevation and date of nesting for these species. However, initiation

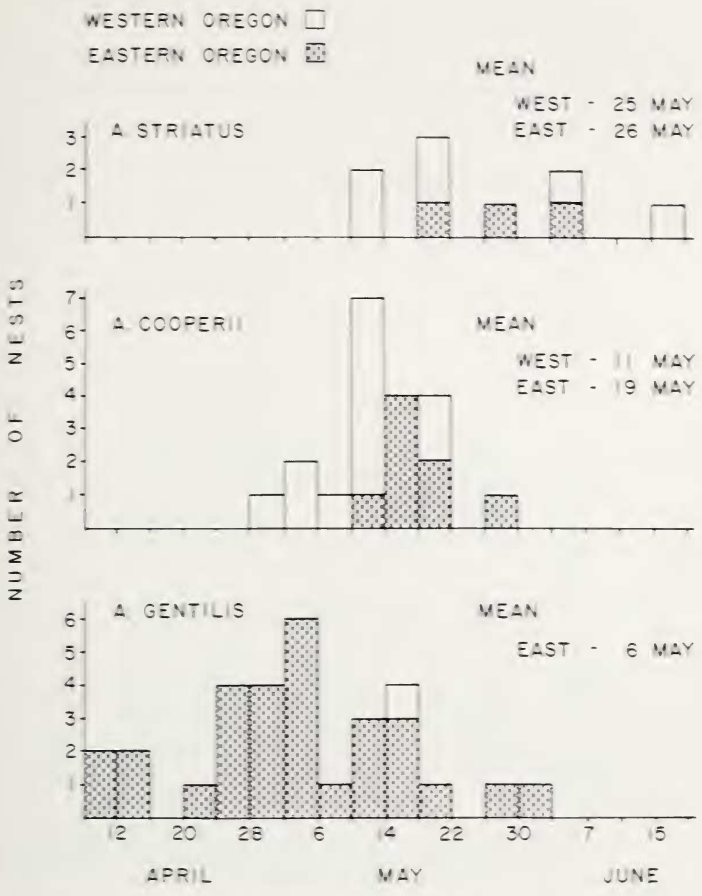

FIG. 3. Number of nests and approximate date of initiation of incubation in Sharp-shinned Hawk, Cooper's Hawk, and Goshawk in Oregon, 1969–1974. Southwestern Oregon not shown due to insufficient number of nests.

of incubation in both species in eastern Oregon was somewhat later than in western Oregon (Fig. 3). In general, clutch size decreased as the size of accipiter increased (Table 2).

Incubation and nestling period.—In Oregon, the incubation period lasted 30–32 days for each accipiter species. This was about the same period reported by McGowan (1975) for Goshawks in Alaska (29 days). Bent (1937) listed 28 days for Goshawks, 24 days for Cooper's Hawks, and 21–24 days for Sharp-shinned Hawks. Brown and Amadon (1968), who summarized much of the literature concerning birds of prey, reported incubation periods of 36 days for Cooper's Hawks and 34–35 days for Sharp-shinned Hawks.

TABLE 2

MEAN NUMBER OF EGGS LAID, EGGS HATCHED, AND YOUNG FLEDGED PER NEST FOR SHARP-SHINNED HAWKS, COOPER'S HAWKS, AND GOSHAWKS IN OREGON

Species	Year	Mean number of eggs	Mean number of eggs hatched	Mean number of young fledged/ nest attempt
Sharp-shinned Hawk	1969	5.0 (3)[a]	3.7 (3)[a]	2.3 (3)[a]
	1970	—	—	—
	1971	3.0 (1)	1.0 (1)	.5 (2)
	1972	5.0 (1)	4.0 (1)	4.5 (2)
	1973	—	—	4.0 (1)
	1974	—	—	3.0 (3)
Total		4.6 (5) (0.89)[b]	3.2 (5) (1.30)[b]	2.7(11) (1.74)[b]
Cooper's Hawk	1969	4.3 (4)	4.0 (4)	2.0 (3)
	1970	4.0 (1)	4.0 (1)	3.3 (3)
	1971	3.8 (4)	2.0 (4)	1.6 (7)
	1972	3.5 (4)	2.3 (4)	2.0 (7)
	1973	—	—	2.5 (2)
	1974	—	—	2.0 (2)
Total		3.8(13) (1.14)	2.8(13) (1.91)	2.1(24) (1.56)
Goshawk	1969	—	—	1.5 (2)
	1970	3.5 (2)	3.0 (2)	1.8 (4)
	1971	3.0 (2)	2.0 (2)	1.6 (5)
	1972	3.0 (1)	3.0 (1)	1.9(22)
	1973	—	—	1.5(11)
	1974	—	—	2.0 (4)
Total		3.2 (5) (0.45)	2.6 (5) (0.89)	1.7 (48) (0.76)

[a] Number of nests.
[b] Standard deviation.

Hatching of all eggs in Sharp-shinned and Cooper's hawk clutches occurred in 1 or 2 days. The time required for hatching of all eggs in a Goshawk clutch was not determined. Nests of each species frequently contained 1 and sometimes 2 eggs that did not hatch. Goshawks covered these with short, green fir boughs, but in Sharp-shinned and Cooper's hawk nests, these eggs frequently remained exposed. Unhatched eggs eventually broke and the shell fragments disappeared.

The nestling period lasted 34–37 days for Goshawks, 27–30 days for Cooper's Hawks, and 21–24 days for Sharp-shinned Hawks. Faster development of the smaller males and their subsequent earlier fledging accounted for much of the variation in length of nestling period within each species.

Mean number of Sharp-shinned Hawks fledged in Oregon was below that

TABLE 3

MEAN CLUTCH SIZE AND NUMBER OF YOUNG FLEDGED PER NEST OF SHARP-SHINNED HAWK, COOPER'S HAWK, AND GOSHAWK IN THIS STUDY COMPARED TO OTHERS

Species	Source	Location	Year	Clutch size	Number fledged/ nest attempt
Sharp-shinned Hawk	This study	Oregon	See Table 2	4.6 (5)[a]	2.7 (11)[a]
	Craighead and Craighead, 1956	Wyoming	1947	3.5 (2)	3.5 (2)
Cooper's Hawk	This study	Oregon	See Table 2	3.8 (13)	2.1 (24)
	Craighead and Craighead, 1956	Michigan	1942	4.3 (6)	2.0 (6)
	Craighead and Craighead, 1956	Michigan	1948	4.0	2.3 (7)
	Meng, 1951	New York	1948–50	4.2 (36)	—
	Henny and Wight, 1972	Northeastern U.S.	1929–45		3.53[b] (118)
			1949–67		2.67[c] (54)
Goshawk	This study	Oregon	See Table 2	3.2 (5)	1.7 (48)
	McGowan, 1975	Alaska	1971	3.1 (10)	2.5 (10)
	McGowan, 1975	Alaska	1972	3.0 (14)	1.8 (14)
	McGowan, 1975	Alaska	1973	3.8 (9)	1.8 (9)
	Hakila, 1968	Finland	1955–58	3.4 (22)	1.5 (28)
	Holstein, 1942	Denmark	1937–40	2.8 (9)	1.8 (9)
	Hoglund, 1964	Fennoscandia	1931–40	3.1 (11)	

[a] Number of nests.
[b] Number of young reaching bandable age per successful nest 1929–1945.
[c] Number of young reaching bandable age per successful nest 1949–1967.

reported for the same species in Wyoming in 1947 (Craighead and Craighead 1956; Table 3). Number of Cooper's Hawks fledged per nest in Oregon was slightly above the number fledged in Michigan in 1942 and slightly below the number fledged in the same area in 1948 (Craighead and Craighead 1956; Table 3). The number of Cooper's Hawk young fledged per successful nest in Oregon was considerably less than the number of young reaching bandable age per successful nest in the years prior to the introduction of organochlorine pesticides and slightly above the number in later years in northeastern United States—2.9 per successful nest in Oregon compared to 3.53 in 1929–1945 and 2.67 in 1949–1967 (Henny and Wight 1972; Table 3). However, since mortality between the time of banding and fledging was not determined, Henny and Wight's (1972) figures were overestimates of productivity and not directly comparable to our data.

TABLE 4

HATCHING SUCCESS,[1] FLEDGING SUCCESS,[2] AND PERCENT OF TOTAL NESTS OF SHARP-SHINNED HAWKS, COOPER'S HAWKS, AND GOSHAWKS IN OREGON THAT FLEDGED AT LEAST ONE YOUNG

Species	% Hatching Success	% Fledging Success	% Successful Nests
Sharp-shinned Hawk	69.9 (5 nests) [a] (23 eggs) [b]	81.2 (5 nests) (16 young) [c]	91.7 (12 nests) [a]
Cooper's Hawk	74.0 (13 nests) (50 eggs)	61.4 (14 nests) (44 young)	69.0 (29 nests)
Goshawk	81.2 (5 nests) (16 eggs)	72.0 (11 nests) (25 young)	90.4 (52 nests)

[1] Number of eggs hatched/number of eggs laid.
[2] Number of young fledged/number of young hatched.
[a] Total number of nests.
[b] Total number of eggs laid.
[c] Total number of young hatched.

Number of Goshawks fledged per nest in Oregon was nearly the same as reported in southwestern Finland (Hakila 1968), Denmark (Holstein 1942), and near Fairbanks, Alaska in 1972 (McGowan 1975), but was nearly 1 young less per nest than in Alaska during 1971 (McGowan 1975; Table 3). However, mean clutch size was nearly the same for all of these locations. Similarities in clutch size in Oregon and Alaska and the relatively high fledging success in Alaska in 1971 suggested that clutch size for this species may be somewhat constant geographically and annually, while hatching and fledging success are influenced by food availability. For example, snowshoe hares (*Lepus americanus*) were the primary food of Goshawks in Alaska during 1970–72 (McGowan 1975). In northern latitudes hare populations are subject to an approximate 10-year population cycle (Keith 1963). In the area of Fairbanks, Alaska hare populations peaked in 1971 and decreased in numbers in 1972 through at least 1973 (McGowan 1975; J. Ernest pers. comm.). High hare density probably accounted for the high fledging success (2.5 young per nest) in 1971. In 1972, however, the number fledged per nest decreased to 1.8 young, and was again 1.8 in 1973 (McGowan 1975). In addition, the number of nests occupied in McGowan's study area was 7 in 1971, 9 in 1972, 8 in 1973, and 1 in 1974.

Age of nesting hawks.—In the North American accipiters, both sexes begin molting into adult plumage in the spring of their first year. Since this molt is not completed until the following fall, nesting accipiters can be identified as immature or adult (2 or more years old) on the basis of plumage. Of 70 Goshawk females and 10 Sharp-shinned Hawk females we observed nesting, all were in mature plumage. However, 2 females (6%) of 34 pairs of

Cooper's Hawks were immature. Males were not observed at all of these nests, but of those seen of each species, all were in mature plumage. Meng (1951) in New York, and N. Snyder (pers. comm.) in Arizona found several immature female Cooper's Hawks, but no immature males breeding. McGowan (1975) found 4 of 11 Goshawk females nesting in Alaska in immature plumage in 1971, while in 1972 and 1973, all were in mature plumage. He observed males at 37% of the nests, and each of these was mature. Hoglund (1964) reported that immature female Goshawks were occasionally found nesting in Finland. On the basis of an examination of testes of 10 immature male Goshawks, all of which varied in size and only 1 of which contained small amounts of mature sperm, Hoglund (1964) concluded that immature males are normally incapable of breeding. However, Glutz von Blotheim (1971) reported that 2 of 30 male (6.7%) and 9 of 93 female (9.7%) Goshawks nesting in central and southern Europe were in immature plumage.

Reynolds (1972) discussed the general lack of nesting by immature males and hypothesized that, since males are the principal food providers during the nesting season, foraging experience is a prerequisite for successful nesting. Immature males. lacking experience, may be subject to greater risks of predation or accident while foraging, and may spend greater energies in territorial establishment and defense than mature birds. Deferring the age of first breeding should increase the future fitness of an immature male. A concomitant of deferred maturity is delayed testicular growth and spermatogenesis.

Post-fledging period.—Young accipiter hawks, as the young of most birds of prey, are dependent on adults for food for some time after fledging. During the early portion of this period fledged young remain close to the nest. As flying skills develop, attachment wanes and young can be found at increasing distances, though their activity remains centered around the nest. Decreased attachment during the latter portion of this period increases the probability of overlooking fledged young when visiting a nest site. For this reason, it is difficult to determine exactly when parental care is terminated, and we report the greatest number of days (the potential length of dependency) young were found in or near the nest site after fledging.

Young of Sharp-shinned Hawks are the most inconspicuous of the 3 species and most difficult to follow once fledged. Eight days was the longest period we observed Sharp-shinned Hawks in the nest site following fledging. However, a pair in Utah, kept under surveillance by radio-telemetry, remained in the nest area for nearly a month before leaving as a family group (Platt 1973). In Oregon fledgling dependency may persist as long as 42 days for Goshawks and 53 days for Cooper's Hawks. We concur with Ashmole and Tovar (1968) who hypothesized that extended fledgling periods in predaceous

birds occurs in species whose prey are difficult to capture, as considerable time is required for development of necessary hunting skills.

Current production trends.—To attempt a relative appraisal of production of accipiters in Oregon, we have included clutch sizes and fledging rates of accipiters from other populations (Table 3). Comparing these production figures to those from Oregon showed that, except for mean clutch size in Cooper's Hawks and mean number of Sharp-shinned Hawks fledged per nest (discussed below), clutch size and fledging rates in Oregon are either greater than or are within the range of the figures from other populations. Of the 3 accipiters in Oregon, Sharp-shinned Hawks had the highest percentage of successful nests (91.7), although Goshawks were close behind (90.4). However, the percent of successful nests of Cooper's Hawks was considerably lower (69.0) (Table 4), with 75% of the failures occurring in western Oregon. Causes of nest failure in Cooper's Hawks ranged from predation upon nestlings (avian, 1 case; mammalian, 1 case), nest destruction (logging, 1 case; windstorm, 1 case), desertion of eggs (1 case) and an unexplained occurrence in which the young either died or were killed and subsequently eaten by the adults (2 cases). Causes of failure of 2 additional Cooper's Hawk, 1 Sharp-shinned Hawk, and 2 Goshawk nests were unknown, while human disturbance caused nest desertion by the same pair of Goshawks during 2 consecutive years.

Hatching success (number of eggs hatched/number of eggs laid) was lowest for Sharp-shinned Hawks (69.6%), intermediate for Cooper's Hawks (74.0%), and highest for Goshawks (81.2%), while fledging success (number of young fledged/number of young hatched) was highest for Sharp-shinned Hawks (81.2%), intermediate for Goshawks (72.0%), and lowest for Cooper's Hawks (61.4%) (Table 4).

Since all nests of Sharp-shinned Hawks hatched young (the 1 unsuccessful nest failed after hatching), the low hatching success of this species resulted primarily from a high incidence of egg loss within clutches through infertility, death of embryo, and egg breakage. Each of these factors, especially egg breakage, may be related to the very high levels of pesticides in eggs reported for Sharp-shinned Hawks in Oregon (Snyder et al. 1973).

Although egg loss is an important factor reducing productivity of Cooper's Hawks, this species suffers its greatest losses during the nestling period. Predation and the unexplained deaths of the young and subsequent consumption by the adults are the 2 most important factors reducing fledging success. Incidence of predation upon nestlings is higher for Cooper's Hawks than either of the other accipiters in Oregon and may be related to habitat used for nesting. Nest sites of Cooper's Hawks, particularly in western Oregon, are sufficiently open to allow the entry of large, winged predators, e.g., crows

(*Corvus brachyrhynchos*), ravens (*C. corax*), and Great Horned Owls (*Bubo virginianus*), while body size of Cooper's Hawks may not be sufficiently large to repel these predators.

Reproductive effort of Goshawks seems to be met with relatively high success in all 3 elements presented in Table 4. Factors decreasing the hatching success of this species are an occasional infertile or addled egg, while most losses of nestlings occur within 10 days of fledging. During this period, dead young were frequently found below nests. Causes of death could not be determined. A few Goshawk eggs were collected in Oregon and analyzed for pesticides. All had relatively low levels, a fact that is consistent with the lack of any noticeable population decline in any region of North America (Snyder et al. 1973).

SUMMARY

Distribution of nests and nesting success were determined for Sharp-shinned Hawks (*Accipiter striatus*), Cooper's Hawks (*A. cooperii*), and Goshawks (*A. gentilis*) in western, southwestern, and eastern Oregon during 1969 through 1974. Nesting density was determined by intensively searching a 9284 ha area in western Oregon and an 11,741 ha area in eastern Oregon. These searches produced 4 Cooper's Hawk nests (1 nest/2321 ha) in 1970 and 5 nests in 1971 (1 nest/1857 ha) in western Oregon and 4 Sharp-shinned Hawk nests (1 nest/2750 ha), 5 Cooper's Hawk nests (1 nest/2200 ha), and 4 Goshawk nests (1 nest/2750 ha) in eastern Oregon. An analysis of hatching success, fledging success, and number of nests that were successful showed that Sharp-shinned Hawks suffered the greatest losses during the incubation period, and Cooper's Hawks and Goshawks during the nestling period.

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